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(71) Applicants
Carla Colombo of Via Perini, 54-Trento, Italy,
Giuseppe Cereghini of Via Perini, 54-Trento, Italy,
Franca Cristoforetti of Via Perini, 54-Trento, Italy,
Trading as Euro-Linea S.N.C. Di Colombo & C., of Via Perini, 54-Trento, Italy
(72) Inventor
Giuseppe Cereghini
(74) Agent
Graham Watt & Co

(54) Mixing Liquids

(57) In the mixing of two liquids components for use in the manufacture of plastics moulding material the liquids are caused to flow under pressure through a restricting orifice where they mix before passing into a mould. Apparatus for performing the mixing has a cylinder divided into two chambers (20, 21) by a partition wall (19), two pistons (22, 23) working within a respective one of the chambers serve to force the liquids through an intercommunicating passage (24, 26) in the partition wall (19). Interpenetration of the liquids after flow through partition wall (19) results in rapid mixing and freedom from premature cross-linking and solidification.

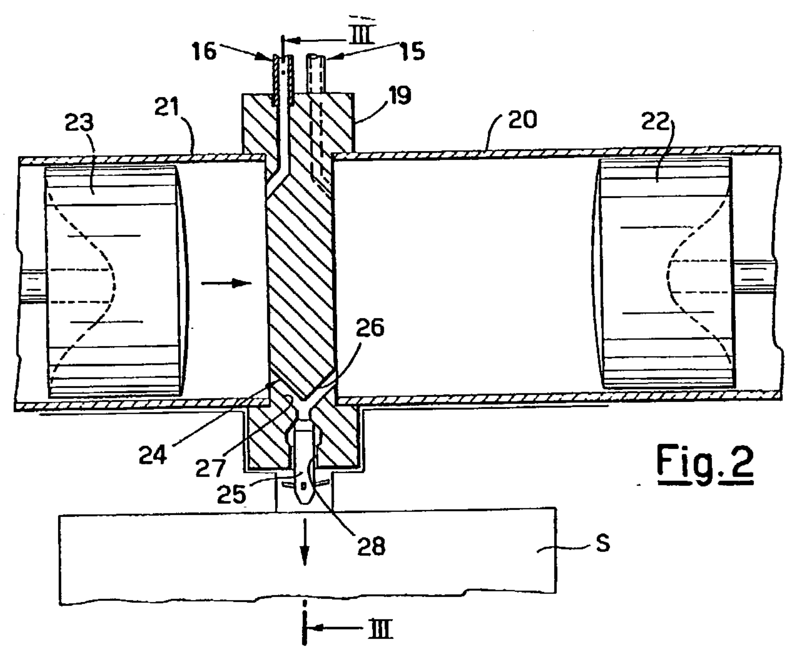

Fig. 2

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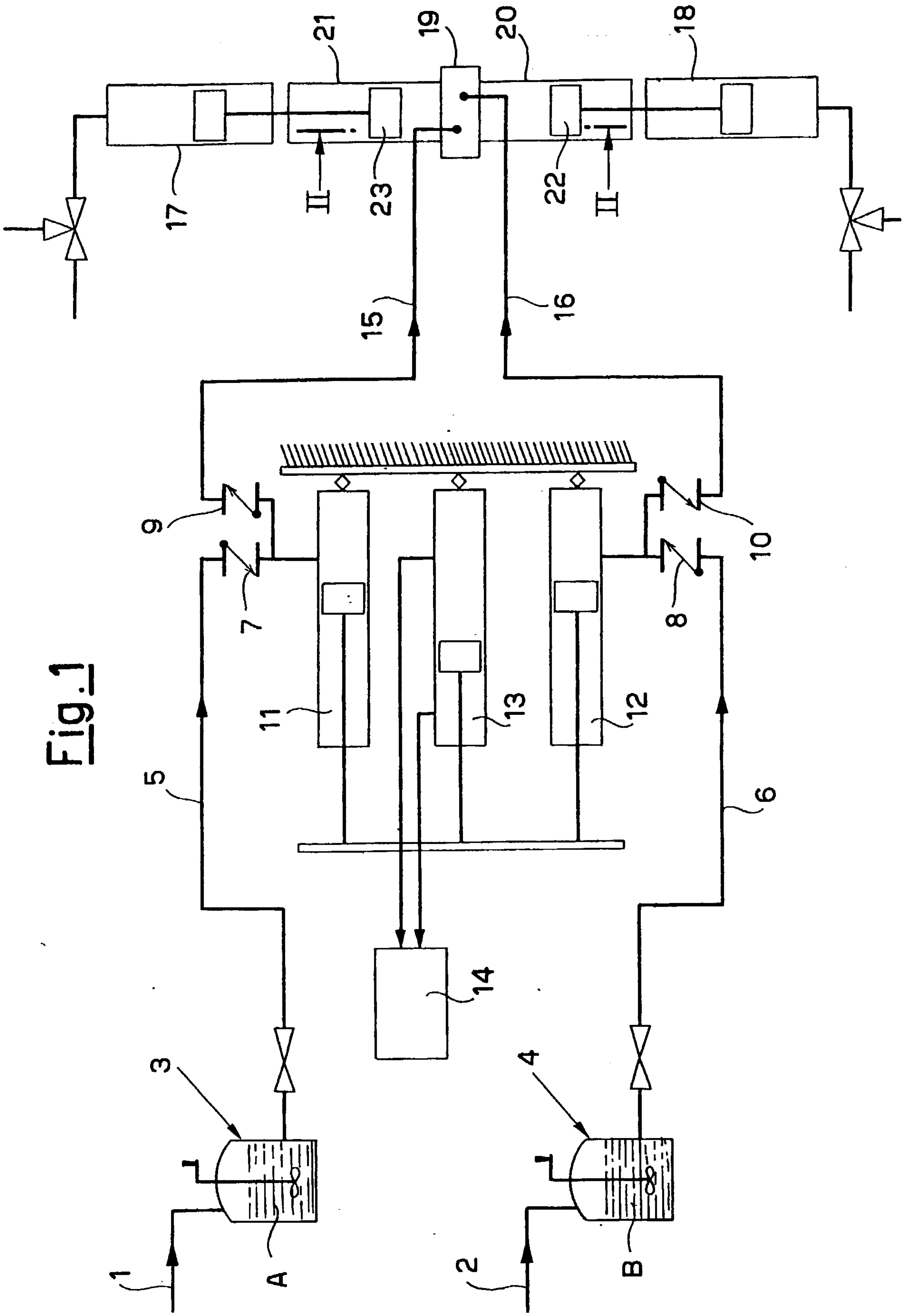

Fig.1

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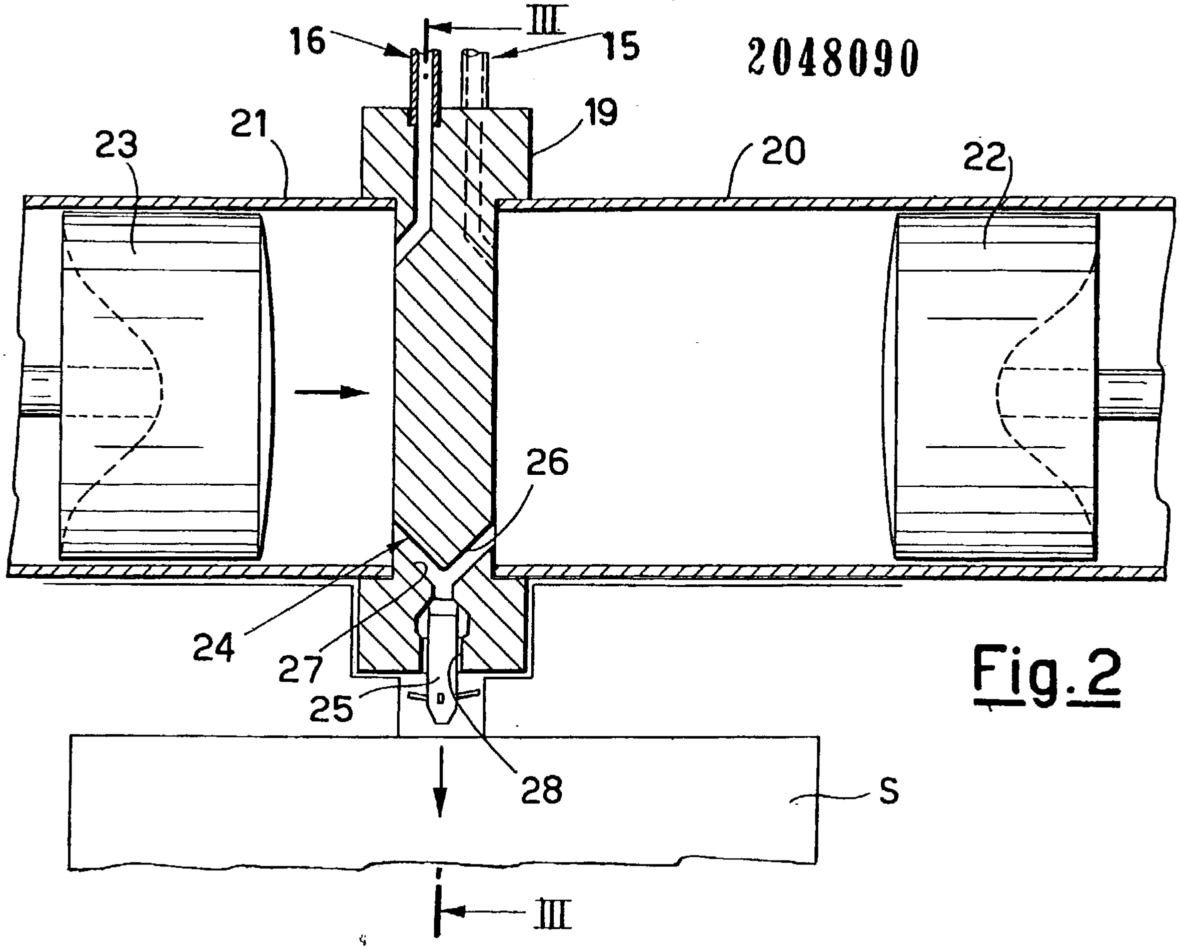

Fig. 2

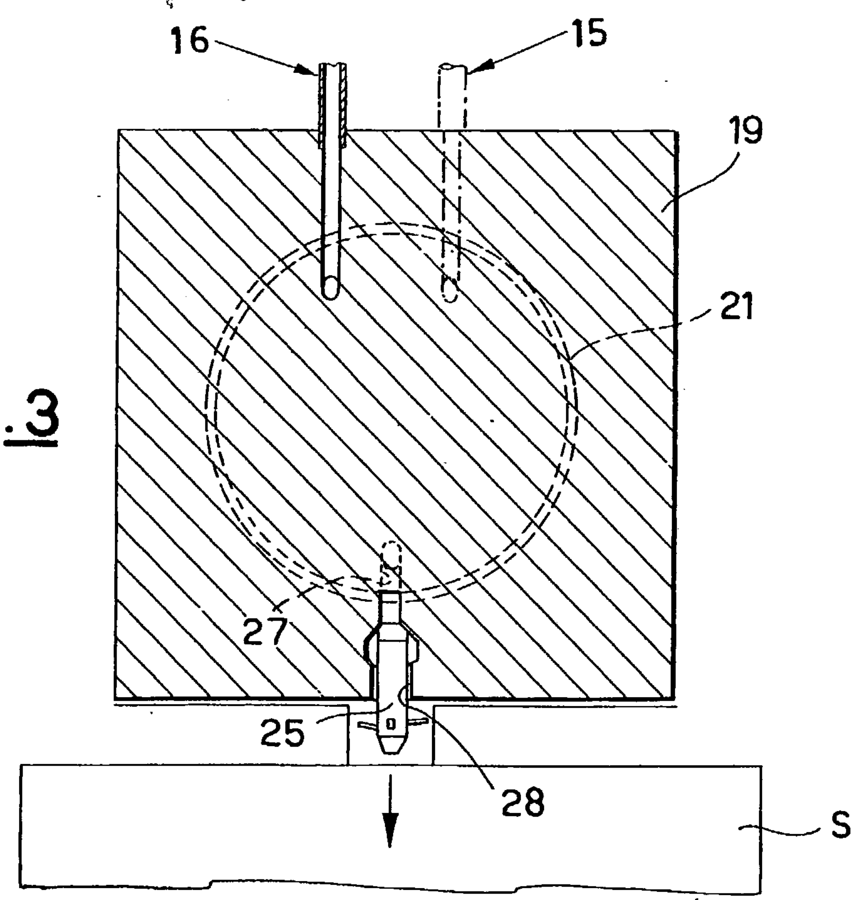

Fig. 3

SPECIFICATION

Liquid Mixing Method and Apparatus

The present invention relates to method and apparatus for mixing at least two liquids, particularly but not exclusively liquid components of a plastics moulding system.

In the technology of transformation of materials which starts from mixtures of liquids, e.g. viscous ones, which are then injected or cast into hollow moulding spaces wherein they harden under certain conditions of cross-linking, with particular regards to mixtures of monomers, cross-linking agents, plasticizers, catalysts active and inert fillers, dyestuffs and so forth, there are two discrete processing stages, viz. the intimate admixture of the components and the injection or casting operation, which generally take place in two discrete locations in the installation.

The circumstance that these processing stages are carried out in two discrete locations of the plant originates a number of shortcomings.

In the first place, the processing times are too long, then the machinery is very bulky, intricate and thus expensive, not only as regards the initial costs but also the running and the upkeep costs.

Another serious defect of the conventional blending systems is that they adopt blenders of the dynamic type such as mills and the like, which are not always in a position to provide that satisfactory intimate admixture of the components which is required to shape certain compounds adequately in order that products exhibiting preselected properties may be obtained.

The present invention aims to redress certain shortcomings outlined above by providing a method for admixing substances of a liquid nature and for feeding the admixture obtained into a shaping mould, the method being capable of being carried out in the same portion of an installation and in sequential processing order without lag times.

The present invention provides a method which may afford intimate admixing of components such as cannot be conventionally mixed.

According to the present invention there is provided a method for admixing at least two liquids and for feeding them into a shaping mould, said method comprising the steps of:

a) Causing a first liquid to flow under pressure within a closed loop or space by having the liquid flowing repeatedly through at least a throttling site for impressing on the liquid a laminar flow motion,

b) Causing to flow in said closed loop or space a second liquid under pressure, together with said first liquid, causing both to pass repeatedly through said throttling site, and

c) Feeding the mixture obtained in said loop or space directly into a shaping mould situated downstream of said closed loop or space.

The present invention also provides a device capable of appropriately performing the method; accordingly there is provided a device comprising a cylindrical chamber for mixing said two liquids together and feeding them admixed to said mould, two counteracting pistons driven to slide within said chamber, a partition diaphragm inserted between said pistons so as to split the chamber into two compartments which communicate through at least one restricted passageway through said diaphragm, feeding ducts for said liquids which open into said chamber, and a valve-controlled discharge nozzle for the liquid mixture.

By way of example only, a preferred exemplary embodiment of an installation adopted to carry out the method according to the invention will now be described with reference to the accompanying drawings, wherein:

Figure 1 shows diagrammatically the operational layout of the installation,

Figure 2 is a longitudinal cross-sectional view showing the admixing device proper, the cross-sectional view being taken along the line II—II of Figure 1, and

Figure 3 is a cross-sectional view taken along the line III—III of Figure 2.

Figure 1 shows the diagram illustrating the principle of the processing installation, starting for example from the two components, A and B, as prepared in the storage tanks 3 and 4, wherefrom, by means of the dry air pressure impressed into the lines 1 and 2, they reach discretely the loading cylinders 11 and 12, via the lines 5 and 6, and through the nonreturn valves 7 and 8.

By displacing the pistons in the loading cylinders 11 and 12 by the agency of the hydraulic system composed by a central unit 14 and the cylinder 13, the chambers 20 and 21 of the injector-mixer of the present invention are filled.

The two charges A and B flow through the nonreturn valves 9 and 10.

The injector mixer is essentially composed by the chambers 20 and 21 and by a separation-admixture diaphragm 19, diagrammatically shown in Figure 2.

The reciprocation of the pistons 22 and 23 in the same direction causes the materials which compose the batches to be blended to become intimately interdispersed. The pistons 22 and 23 are actuated by counterpistons contained in compressed air cylinders 17 and 18. Due to the actuation of the pistons 22 and 23 the batches flow under pressure through the passgeway 24 of communication between the two chambers, in such a mode of flow as to have high values of the sliding velocity gradient.

The shear stress at the wall will thus become the greater, the higher the viscosities of the batches

and of the mixture will be. Preferably, to this purpose, the passageway 24 comprises two branches 26, 27 which converge into a mixture discharge nozzle 28.

In comparison with other static mixers, it has surprisingly been found that there is no necessity of splitting the streams into a number of fillets during the flow of the materials, but that it is sufficient to work under conditions of high shear stresses in order that a satisfactory compenetration of the batches to be mixed may be achieved.

Of course, the motion of reciprocation of the two pistons in the injection and admixture chamber takes place with the valves 9, 10 and 25 shut.

For the injection or casting of the admixed materials, the valve 25 is opened and the two pistons 22 and 23 are actuated either singly or together (consistently with the amount of material to be injected), so as to feed the mixture, through the nozzle 28, into the mould, which has been diagrammatically shown at S.

When charges subsequent to the first are carried out with unblended material, the latter acts as a diluent of possible incrustations due to premature cross-linking and/or stagnation of material, so that the succession of the charges permits to consider the system as self-cleaning, with apparent technical and economical advantage.

In this connection, it is preferred to feed and to subject to laminar flow through the passageway 24 the first batch, then to feed in the second batch and subject them to laminar flow together.

With the apparatus shown in Figures 1, 2 and 3, there have been carried out process runs of polyurethan and the results are tabulated in the ensuing Examples.

Example 1

Batch A is a polyurethan elastomer based on isocyanates of the kind of Adiprene L 100 (Reg. Trade Mark) of the DuPont Company, having the following properties:

Specific gravity at 25°C	1.06
Brookfield viscosity at 30°C	18.000 cps
Average isocyanate contents	4.1%

Batch B is a mixture of plasticizer, cross-linking agent and catalyst.

The plasticizer is DOP (dioctyl phthalate), the cross-linking agent is MOCA (Reg. Trade Mark) of DuPont (4,4′-methylene-bis-2-chloroaniline) and the catalyst is adipic acid.

The operative variable was taken as the increasing number of reciprocations of the pistons 22 and 23 in the opposite directions. While accepting the principle that the final characteristics are, as an average, those obtainable as maxima with the relative compounds, there have been statistically evaluated the coefficients of variation for tests repeated 20 times on the same sample, by detecting the decrease as a function of the number of reciprocations of the pistons and the constancy after the second movement. The values of the coefficients of variation have a magnitude which virtually corresponds to the errors of the measuring methods. This fact means that by actuating the pistons 22, 23 only twice prior to the effecting the casting or the injection into the mould, a perfect homogenization of the blend is achieved.

The compound formulae and the results are tabulated hereunder.

Adiprene L 100	100	100	100	100
Moca	12.5	12.5	12.5	12.5
DOP	40	40	40	40
Adipic acid	0.15	0.15	0.15	0.15
N° reciprocations	1	2	3	10
Admixing temperature, °C	100	100	100	100
Cross-linking time, hrs	3	3	3	3
Temperature of cross-linking °C	100	100	100	100
Post-cross-linking, hrs	160	160	160	160
Post-cross linking tempt. °C	24	24	24	24
Hardness, Shore A	81	82	81	81
Modulus at 100% el., kg/cm^2	37	37	38	37
Modulus at 300% el., kg/cm^2	60	62	61	60
Tensile strength, kg/cm^2	205	210	212	210
Elong. at break, %	600	610	620	615
Compression set, % (22 hrs at 70°C)	40	41	39	40
Resilience, % (Bashore)	51	50	51	51
Variation Coefficients in %				
Hardness	14	8	7	8
Tensile strength	16	10	8	9
Resilience	10	7	8	7

Example 2

The same procedure of Example 1 has been adopted but a dyestuff has been added to the formulation (for example, in an epoxy base paste).

There have been obtained the same results as for Example 1.

The dyestuff has been admixed as a component of batch B and the microscopical analysis has shown that it had been finely dispersed.

Example 3

The batch A is Adiprene L 100 (Reg. Trade Mark), the batch B is a mixture of DOP and methylene dianiline. The blending has been obtained with 1 and 3 reciprocations of the pistons.

Adiprene L 100	100	100
DOP	50	50
Methylene dianiline	9.6	9.6
Admixture temperature, °C	66	66
Time of removal from moulds, mins.	3	3
Cross-linking time at 100°C, hrs	1	1
Conditioning time UR 50%) at 24°C, hrs	160	160
Piston reciprocations, N°	1	3
Modulus at 100% el.kg/cm²	40	39
Modulus at 300% el. kg/cm²	55	56
Tensile strength, kg/cm²	190	200
Elong. at break, %	600	630
Hardness, Shore A	73	73
Compress. set (B), %, 22 hrs at 70°C	25	27
Resilience (Bashore), %	53	52
Coefficients of Variation %:		
Tensile strength	20	10
Elongation at break	15	9
Hardness	20	8

Example 4

Batch A is Diprene L 100 (Reg. Trade Mark) supplemented by ferric acetylacetonate as the catalyst.

Batch B is composed by Adiprene L 100 (Reg. Trade Mark) and polyols as cross-linking agents (1,4-butanediol and trimethylol propane).

The number of reciprocations of the pistons 22, 23 has been varied and the coefficients of variation has been calculated as for Example 1. The formulations and the results which have been obtained are tabulated hereunder:

Adiprene L 100	100	100	100	100
1,4-butanediol	3.5	3.5	3.5	3.5
Trimethylolpropane	0.8	0.8	0.8	0.8
Ferric acetylacetonate	0.01	0.01	0.01	0.01
Cross-linking, hrs/°C	6 at 100	6 at 100	6 at 100	6 at 100
Post cross-linking, hrs (U.R. 50% at 24°C)	160	160	160	160
Piston reciprocations, N°	1	2	3	10
Modulus at 100% el.kg/cm²	19	20	18	19
Modulus at 300% el.kg/cm²	33	30	35	34
Tensile strength, kg/cm²	137	142	136	138
Elong. at break, %	500	480	510	500
Shore A Hardness	58	57	58	58
Coefficients of Variation in %:				
Tensile strength	22	12	11	9
Elongation at break	18	8	9	8
Hardness	16	10	12	10

Thus, according to the invention, the admixture is effected by a static blender based on the flow of the materials through appropriate ports, under such conditions of flow as to provide a complete interpenetration of the components by virtue of the shearing stresses which are thus generated. The absence of mechanical component parts in movement in the interior of the mass of the ingredients of the admixture prevents the formation of incrustations which could be caused by the materials clinging around such parts as shafts and helices (mixer screws). Such incrustations are often due to premature

polymerizations or premature cross-linking as generated by differential stresses around moving shafts and by the stirring time as required in a usual dynamic blender to effect the admixture in question.

In the case in point the times which are required for effecting blending may be reduced to a few seconds, so that hardening phenomena are minimized prior to injection and it becomes possible to work at temperatures which are sufficiently high to minimize also the cross-linking cycles.

Claims

1. A method for admixing at least two liquids and feeding them into a moulding space, comprising the steps of:
   a) Circulating a first pressurized liquid within a closed space by having the liquid flowing repeatedly through at least one throttling passageway to induce laminar flow in the liquid,
   b) circulating through said space a second pressurized liquid together with the first pressurized liquid by causing both to flow repeatedly through said throttling passageway, and
   c) feeding the admixture as formed in said space directly into a shaping mould placed downstream of said space.

2. A device for performing the method of Claim 1, which comprises a cylindrical chamber for admixing said two liquids together and for feeding the mixture obtained into said mould, two counteracting pistons drivable so as to slide within said chamber, a partition diaphragm inserted between said pistons so as to partition said chamber into two compartments which communicate with one another through at least one passageway formed through said diaphragm, feeding ducts for said liquids which open into said chamber and a discharge nozzle for said mixture which is controlled by a valve means.

3. A device according to Claim 2, in which the said ducts and said nozzle are formed through said partition diaphragm.

4. A device according to Claim 2, in which that said passageway comprises two branches which converge into said nozzle.

5. A method of admixing at least two liquids substantially as herein described with reference to the accompanying drawings.

6. Admixed liquids prepared by the method according to claim 1 and in accordance with any of Examples 1 to 4.

7. A device for admixing at least two liquids substantially as herein described with reference to and as shown in Figures 2 and 3 of the accompanying drawings.

8. A device according to claim 7 when incorporated in plant substantially as herein described with reference to Figure 1 of the accompanying drawings.

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